

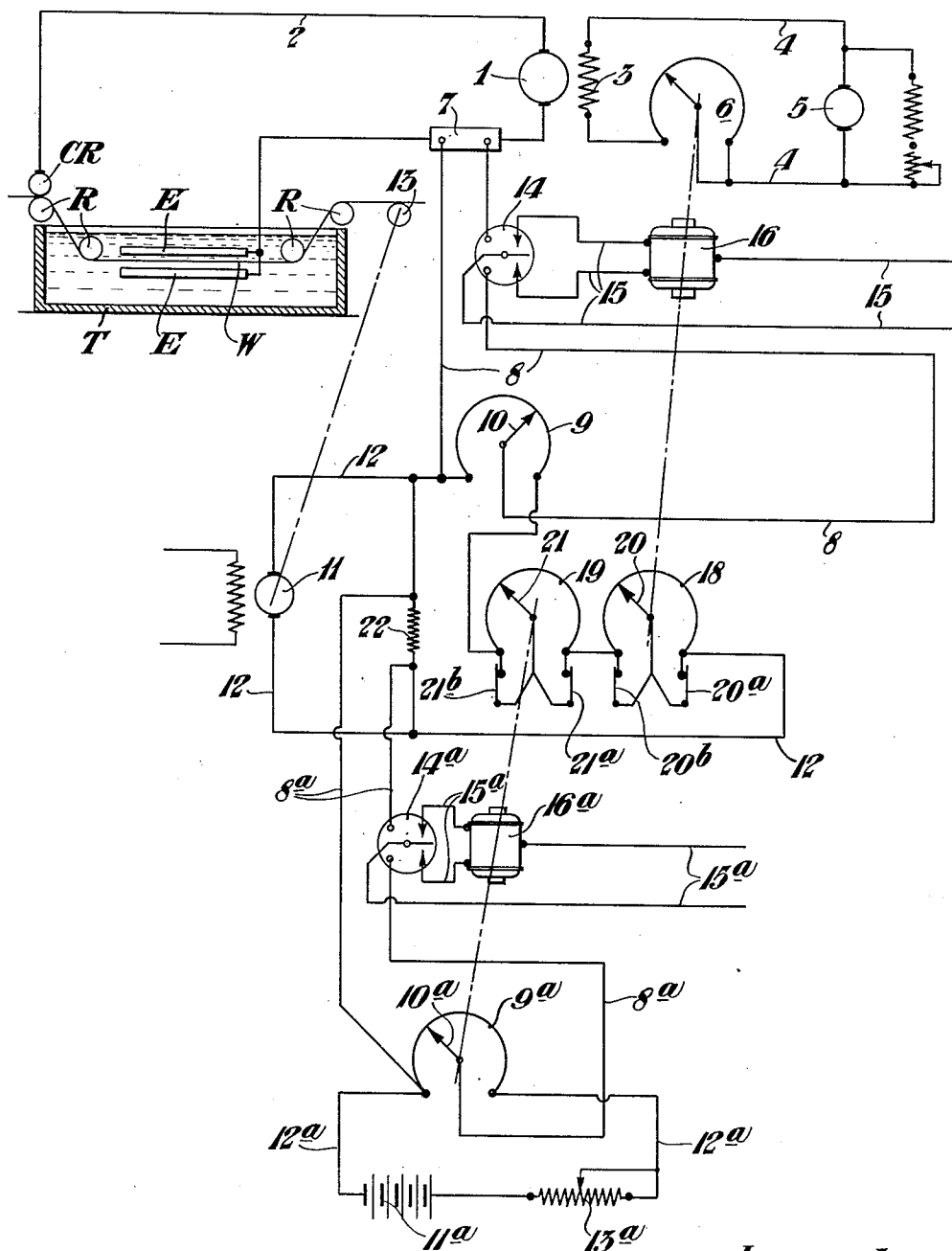
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ELECTROPLATING APPARATUS

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ELECTROPLATING APPARATUS

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This invention is primarily concerned with apparatus for electroplating metal strip, wire and similar work passed continuously through an electrolyte at varying traveling speed. However, the principles of the invention may be considered applicable to other electrolytic treatment of such work.

The accompanying drawing schematically illustrates an example of apparatus embodying the principles of the invention.

In this drawing, the work W is shown as being passed continuously through an electrolyte in a tank T, this being done by means of guide rollers R. It is to be understood that although the value of the traveling speed of this work may be a constant a great deal of the time, this value varies one or more times during the passage of the work through the electrolyte. For instance, assuming the work to be strip steel and the tank T and rollers R to represent part of a group of equipment for electroplating this strip, it may be necessary to slow down the normal traveling speed of the strip when it becomes time to fasten its trailing end to the leading end of another length of strip whereby to thread the latter through the equipment, the speed then being returned to normal.

The armature 1 of a driven generator establishes an electric current between the electrolyte in the tank T and the work W through a circuit 2 which includes a work contactor roller CR and electrodes E immersed in the electrolyte in the tank T above and below the work passing through this electrolyte. If the work is being electroplated, these electrodes may comprise the plating metal. The output of the armature 1 is directly proportional to the strength of the generator's field 3 which is powered through a circuit 4 by an exciting generator 5, this circuit 4 containing a rheostat 6 for controlling the strength of the field 3.

It is obvious that the electroplating or other electrolytic effect produced on the work W will be of a constant value as long as the traveling speed of the work and the output of the armature 1 have constant values, assuming that those factors affecting the efficiency of the electrolytic effect remain constant. Thus, the temperature and composition of the electrolyte affect the efficiency of the electrolytic effect, but these factors can be held to constant values. Other less controllable factors affecting the efficiency of the electrolytic effect will be discussed later.

When the value of the traveling speed of the work W varies, it is obvious that the electrolytic effect of the current on the work must also vary, 55

and such variation will also occur if the value of the current established between the work and the electrodes should vary for any reason. The primary function of the present invention is to prevent variations in these values from affecting the electrolytic effect produced on the work by the current between the work and the electrodes, the invention serving to hold this effect constant at all times.

Keeping the above in mind, the circuit 2 includes a shunt 7, and a shunt circuit 8 is in shunt connection with this shunt 7. This circuit 8 also includes the portion of a slide wire 9 selected by a contactor 10 working on this slide wire. The slide wire 9 is connected to a small generator 11 by a circuit 12, this generator having a fixed field strength so that its voltage is directly proportional to its speed and being driven through a work contacting roller 13 by the traveling work W so that the voltage applied the circuit 12 and the slide wire 9 is directly proportional to the value of the traveling speed of the work W.

The circuit 12 connects the generator 11 with the slide wire 9 respecting the connection of the shunt circuit 8 with the contactor 10 and the portion of the slide wire 9 selected thereby, so that the voltage applied the circuit 8 by the drop in the shunt 7 opposes that applied this circuit by the drop in the portion of the slide wire 9 included in the circuit 8 by the contactor 10. When the two voltages are equal no current flows in the circuit 8 but when they are unbalanced current flows in the circuit in one direction or another depending on which source is of the higher voltage.

The operating coil of a contact-making galvanometer 14 is included in the circuit 8, the contacts of this galvanometer 14 controlling the reversing circuit 15 of a small reversing motor 16 which works the controlling element of the rheostat 6. When the voltage taken from the shunt 7 is higher than that taken from the slide wire 9 by the contactor 10, the galvanometer 14 causes the motor 16 to operate in a direction moving the controller of the rheostat 6 so as to reduce the strength of the field 3, whereupon the output of the armature 1 drops until the voltage taken from the shunt 7 balances that taken from the slide wire 9 by the contactor 10. When the voltage taken from the shunt 7 is less than that taken from the slide wire 9 by the contactor 10, the function is opposite, the strength of the field 3 being increased until the output of the armature 1 increases so that the voltage taken from

the shunt 7 balances that taken from the slide wire 9 by the contactor 10.

Since the voltage taken from the shunt 7 is directly proportional to the value of the current between the electrolyte and the work, and since the voltage selected from the slide wire 9 by the contactor 10 is directly proportional to the value of the traveling speed of the work, the apparatus as so far described provides for the continuous maintenance of a ratio between these values that is a constant value. This ratio is not only maintained constant when the traveling speed value varies, but is also maintained constant should the electrolyzing current value vary for any reason, the shunt 7 being in the same circuit with the electrodes E and the work W whereby should the electrolyzing current drop, the voltage applied the circuit 8 from the shunt 7 also drops, whereupon the apparatus reestablishes the ratio.

Another important feature is that this ratio between the current and speed values can be given any value desired by moving the contactor 10 over the slide wire 9 so as to vary the ratio between the voltage produced by the generator 11 and that applied the circuit 8 from this generator by way of the slide wire 9 and contactor 10. For instance, in the case of electroplating, it may be desired to increase the weight of plate applied the work, and this may be done simply by adjusting the contactor 10 so that the ratio between the voltage produced by the generator 11 and that applied the circuit 8 from this generator by way of the slide wire 9 and its contactor 10 is increased, this in effect increases the ratio of plating current to traveling speed at which the apparatus operates. Conversely, the weight of the plate may be decreased by adjusting the contactor 10 to decrease the current to traveling speed ratio. Once the ratio has been selected, the apparatus maintains its value constant, the rheostat 6 being practically immediately adjusted upon any changes in the value of this ratio so as to establish the value selected.

It was previously mentioned that the temperature and composition of the bath may be kept at constant values. However, the efficiency of the electrolytic effect on the work may also vary in accordance with the electrolyzing current and the travelling speed values. That is to say, when the traveling speed value varies the electrolytic effect produced on the work may not be the same even though the ratio of electrolyzing current to traveling speed is maintained at a constant value by the apparatus previously described. In some instances, the ratio between the current and the traveling speed values must be increased as the traveling speed value increases, while in other instances the ratio must be decreased. In addition, it is sometimes necessary to increase the ratio as the current value increases, or to decrease this ratio when the current value decreases. All this obviously presents complications.

Returning to the drawing, in addition to the slide wire 9 the circuit 12 may be made to include the resistances 18 and 19 of two rheostats. The controlling elements 20 and 21 of the latter are connected into the circuit 12 by the switches 20^a and 20^b, and 21^a and 21^b, respectively. The resistances 18 and 19 are ineffective when all four switches are closed, as shown in the drawing.

The element 20 is mechanically connected with the motor 16, making it move with the element of

the rheostat 6 so that when the switches 21^a and 21^b are closed to make the resistance 19 ineffective and either switch 20^a or 20^b is opened, more or less of the resistance 18 will be placed in the circuit 12 and so in series with the slide wire 9, the amount of this resistance depending on the operation of the motor 16. When the switch 20^a is closed and the switch 20^b opened, more of the resistance 18 is placed in series with the slide wire 9 as the motor 16 moves the element of the rheostat 6 so as to reduce the field strength 3. It follows that as the output of the armature 1 decreases, the voltage taken from the slide wire 9 by the contactor 10 automatically decreases, whereby the ratio between the electrolyzing current value and the traveling speed value decreases as the electrolyzing current decreases. The opposite effect is secured when the switch 20^b is closed and the switch 20^a is opened, and when both switches are closed, the resistance 18 has no effect on the voltage in the slide wire 9. The apparatus then maintains the ratio between the current and the traveling speed values at a constant value as previously described.

The controller 21 of the resistance 19 is operated by a reversing motor 16^a, a fixed resistance 22 being placed across the circuit 12. The voltage drop across the resistance 22 is directly proportional to the output of the generator 11 and, therefore, to the traveling speed of the work W. The motor 16^a is controlled in substantially the same manner as described in connection with the motor 16. For this reason the various parts involved are numbered the same as those involved in the control of the motor 16 and are identified by the letter *a*, the only difference being that the slide wire 9^a is energized by a battery 11^a controlled by a variable resistance 13^a, and the contactor 10^a being driven by the motor 16^a so that the voltage taken from slide wire 9^a by the contactor 10^a is maintained equal to that across the resistance 22.

With the above arrangement, when the value of the voltage in the circuit 12 varies by reason of the traveling speed value varying, current flows in the circuit 8^a in one direction or another depending on whether the voltage taken from the slide wire 9^a is greater or less than that taken from the resistance 22. Therefore, assuming the switches 20^a and 20^b to be closed, it is possible to vary the voltage in the slide wire 9 so as to result in the value of the ratio between the current and the traveling speed values either increasing or decreasing as the traveling speed value varies. The effect secured depends on the operation of the switches 21^a and 21^b.

When both resistances 18 and 19 are made effective the ratio of electrolyzing current to traveling speed is automatically changed to compensate changes in efficiency of the electrolytic effect on the work resulting from changes in either or both electrolyzing current and traveling speed.

It is to be understood that the rheostats including the resistances 18 and 19 must be calibrated to operate in accordance with the characteristics of the electrolyte being used and the electrolytic action involved. In some instances these factors are known, but, in any event, they can be experimentally determined.

The present invention is a continuation, in part, of the invention disclosed in a copending application filed by the same inventor on February 23, 1937, and bearing Serial No. 127,276.

I claim:

1. Apparatus for electrolytically treating metal

strip and wire work, including the combination of an electrolyte, equipment for passing said work continuously through said electrolyte at a varying traveling speed, a first electric circuit including said work and said electrolyte, electric powering means for said first circuit, a second electric circuit, means for obtaining an electric voltage in said second circuit proportional to the current in said first circuit, means for obtaining an electric voltage in said second circuit proportional to said traveling speed in opposition to the voltage obtained by the second named means and means responsive to the direction of the current flow in said second circuit for varying the output of said powering means, said combination further including adjustable means for varying the voltage obtained in said second circuit by at least one of said means for obtaining an electric voltage therein.

2. Apparatus for electrolytically treating metal strip and wire work, including the combination of an electrolyte, equipment for passing said work continuously through said electrolyte at a varying traveling speed, a first electric circuit including said work and said electrolyte, electric powering means for said first circuit, a second electric circuit, means for obtaining an electric voltage in said second circuit proportional to the current in said first circuit, means for obtaining an electric voltage in said second circuit proportional to said traveling speed in opposition to the voltage obtained by the second named means, and means responsive to the direction of the current flow in said second circuit for varying the output of said powering means.

3. Apparatus for electrolytically treating metal strip and wire work, including the combination

of an electrolyte, equipment for passing said work continuously through said electrolyte at a varying traveling speed, a first electric circuit including said work and said electrolyte, electric powering means for said first circuit, a second electric circuit, means for obtaining an electric voltage in said second circuit proportional to the current in said first circuit, means for obtaining an electric voltage in said second circuit proportional to said traveling speed in opposition to the voltage obtained by the second named means, and means responsive to the direction of the current flow in said second circuit for varying the output of said powering means, said second circuit including means responsive to operation of the fourth named means for varying the current flow in said second circuit.

4. Apparatus for electrolytically treating metal strip and wire work, including the combination of an electrolyte equipment for passing said work continuously through said electrolyte at a varying traveling speed, a first electric circuit including said work and said electrolyte, electric powering means for said first circuit, a second electric circuit, means for obtaining an electric voltage in said second circuit proportional to the current in said first circuit, means for obtaining an electric voltage in said second circuit proportional to said traveling speed in opposition to the voltage obtained by the second named means, and means responsive to the direction of the current flow in said second circuit for varying the output of said powering means, said second circuit including means responsive to said traveling speed for varying the current flow in said second circuit.

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